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Research Article

Dual Channel Pricing of Large Fresh Chain Stores Considering Distribution Costs under Split Quotation

Weiqun Xiao*, Siqi Ren, Wulei Mao

Beijing Wuzi University, Beijing 101149, China

Abstract: After large fresh food chain stores have opened online channels, distribution costs are a key factor affecting consumers' online buying behavior, which affects dual-channel pricing. This paper studies the dual-channel pricing strategy of large fresh food chain stores on the premise of dividing the quotation, considering the consumer's acceptance of online channels and the sensitivity to distribution costs. The research found that the optimal pricing of online channels is lower than that of retail channels. The optimal pricing of online channels is positively correlated with the acceptance of online channels, and negatively correlated with the sensitivity of consumer distribution costs. Moreover, after retailers have opened online channels, the market scale has expanded compared with traditional retail channels. Finally, numerical experiments are used to analyze the influence of various influencing factors on retailers' decision-making.

Keywords: Pricing strategy; Sensitivity of distribution costs; Acceptance of online channels

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****Corresponding author:*** Weiqun Xiao, djkxwq@126.com

1 Introduction

The pricing problem of dual - channel supply chain is a field worthy of further study. When enterprises introduce online channels, finding an appropriate regulatory factor to solve the dual-channel pricing problem is a current research hotspot[1]. At present, there are more and more researches on the price leadership of retailers. Some studies focus on the analysis of different consumers, dividing consumers into consumers with independent retail channel preferences and consumers with multi-channel preferences [2] or consumers with online channel preferences and offline channel preferences[3]. Some researchers focus on analyzing the influencing factors of dual-channel demand of retailers, such as price, free-riding behavior of consumers, reputation of retailers and social influence. Considering the different price sensitivity of customers, Gao et al. (2017) concluded that the greater the price discount in online channels, the greater the bullwhip effect in online sales, according to the characteristics of price sensitivity of consumers [4]. In terms of the impact of delivery date on dual-channel demand, Lu Tao and Zhang Shibin (2019) analyzed the impact of price and delivery date sensitivity on retailers' dual-channel demand, and concluded that retailers' online channel price would decrease with the extension of delivery time [5]. There are also some other influencing factors. Liu Xiaofeng et al. (2016) considered the impact of consumer free-riding behavior on dual-channel pricing [6]. Based on the reputation of retailers, Li Pei and Wei Hang (2017) analyzed the opening of B2C platform of offline retailers under certain conditions and the pricing issues of whether online retailers enter [7]. Zhang Aifeng, Xian Chunlan and Guan Zhenzhong (2019), considering the influence of dual-channel social interaction on consumers, analyzed and compared the three pricing strategies and finally reached the conclusion that dynamic pricing strategy prevailed [8].

The above research focuses on analyzing the influencing factors of dual-channel demand of retailers. In addition, distribution service plays an important role in the adjustment of online customer demand. It is not satisfactory for consumers to bear the logistics costs [9], but if the fresh retailers bear all the logistics costs, the retail enterprises may lose money [10]. Distribution costs are generally not included in the product price in the pricing of online products of fresh chain stores, which means split quotation is adopted. Empirical studies show that when segmentation price is reasonable, it helps to enhance customers' purchase intention and improve customer satisfaction and utility value [11]. In addition, when logistics service fee is reasonable, segmenting quotation is more effective than bundling quotation for people with high cognitive needs [12]. Current researches on distribution cost mostly focus on reducing logistics distribution cost [13-14] or taking distribution cost as a moderating factor to explore its influence on the scale of online retail channels [15]. In terms of studying the impact of distribution costs on the pricing of online products, Tian Junfeng and Tian Jinsong (2016) have studied the use conditions and influence mechanisms of the two quotations for distribution costs and online channel products in two forms: split quotation and bundle quotation, but No research has been conducted on the impact of distribution costs on network channel products under the condition of split quotation [16].

Reviewing the literature, there are few studies on dual-channel pricing that take distribution cost as a moderating factor. Therefore, this paper studies the dual channel pricing under the dual effects of channel preference and distribution cost under the condition of split pricing for large fresh chain stores.

2 Problem description and assumptions

2.1 Problem Description

As shown in Figure 1, this paper considers the model of large fresh chain stores selling a single product through both online and offline channels. Under the condition of split quotation, the distribution cost is assumed to be certain, and the proportion of consumers to bear the distribution cost affects the scale of the channel and the pricing of the product.

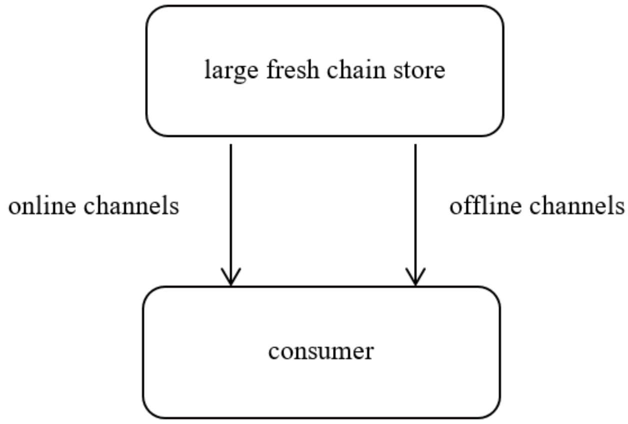

Figure 1. Retailer's dual-channel supply chain

2.2 Model assumptions

Table 1. Parameter assumption

U_r	the utility of consumers choosing offline channels	s	the delivery cost per order (The consumer bears s_1 and the supermarket bears s_2 , so that $s_1+s_2=s$)
U_e	the utility of consumers choosing online channels	D_e	the network channel demand
a	consumers' online channel preferences, $\alpha\in[0,1]$	D_r	retail channel demand
v	consumers' assessment of the value of goods, and v is uniformly distributed over the interval [0,1]	D_S	the total demand of a single channel
μ	consumer's sensitivity to delivery costs	D_r^d	the retail channel demand in dual channels
c_e	the commodity cost of the network channel	D_d	the total demand for dual channels
c_r	the cost of goods in the retail channel	π	the total revenue of dual channels
p_r	the retail channel commodity price	π_e	the network channel revenue
p_e	the online channel commodity price	π_r	the retail channel revenue

3 Model building

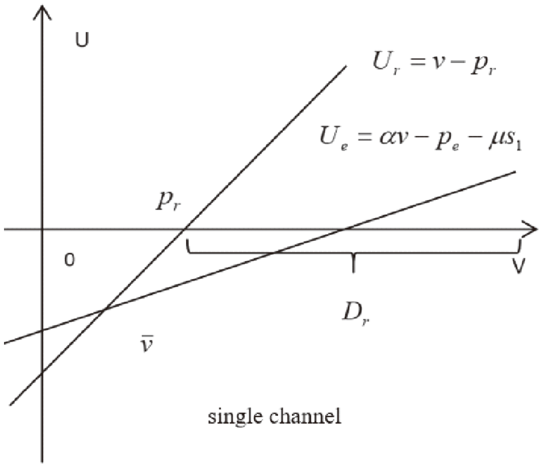

Figure 2. Consumer utility function when single channel exists

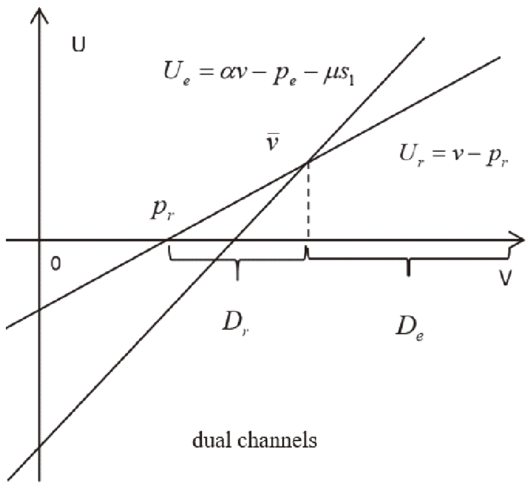

Figure 3. Consumer utility function in the presence of dual channels

The utility obtained by consumers in online channels is $U_e = \alpha v - p_e - \mu s_1$, and the utility obtained in retail channels is $U_r = v - p_r$. According to the utility theory, purchasing behavior will only occur when the consumer's utility is greater than or equal to zero, and the purchase of goods that maximize their utility must satisfy the constraints of personal rationality and incentive compatibility. The personal rationality constraint is $U_r \geq 0, U_e \geq 0$. When $v \geq \frac{p_e + \mu s_1}{\alpha}$, consumers may choose online channels; When $v \geq p_r$, consumers may choose retail channels. Incentive constraints is that when $U_r \geq U_e$ consumers will choose retail channels and when $U_r \leq U_e$ consumers may choose online channels. When $U_r = U_e$, the two utility functions meet at one point $\bar{v} = \frac{p_r - p_e - \mu s_1}{1-\alpha}$. Figure 2 shows that, when $p_r > \bar{v}$, that is $p_e + \mu s_1 > \alpha p_r$, there is only a single retail channel; As can be seen from Figure 3, when $p_r \leq \bar{v}$, that is $p_e + \mu s_1 \leq \alpha p_r$, there are two channels, and the total profit of the two channels is π. At this time

$v \in \left[\frac{p_e + \mu s_1}{\alpha}, \ \bar{v}\right]$'s consumer choice network channel, $D_e = \bar{v} - \frac{p_e + \mu s_1}{\alpha}$

$v \in [\bar{v}, 1]$'s consumer choice network channel, $D_r = 1 - \bar{v}$

Proposition 1. When $p_e + \mu s_1 \leq \alpha p_r$, the retailer's profit is:

$$\begin{aligned}\pi &= \pi_e + \pi_r \\ &= (p_e - c_e - s_2)D_e + (p_r - c_r)D_r \\ &= (p_e - c_e - s_2)\left(\frac{p_r - p_e - \mu s_1}{1-\alpha} - \frac{p_e + \mu s_1}{\alpha}\right) + (p_r - c_r)\left(1 - \frac{p_r - p_e - \mu s_1}{1-\alpha}\right)\end{aligned}$$

According to the principle of profit maximization, when the fresh food chain stores and consumers share the distribution costs, the dual-channel optimal pricing and the distribution costs of the consumers are as follows: $p_e^* = \frac{\alpha + s_2 + c_e - \mu s_1}{2}, p_r^* = \frac{1 + c_r}{2}$

Corollary 1. With other conditions unchanged, network channel pricing is an increasing function of network channel acceptance degree α and a decreasing function of distribution cost sensitivity coefficient μ.

Corollary 2. After the optimal pricing is substituted into the retailer's profit function, the retailer's profit is:

$$\pi = \frac{(\alpha c_r - s_2 - c_e - \mu s_1)(\alpha - s_2 - c_e - \mu s_1) + \alpha(1 - c_r)(1 - \alpha - c_r + s_2 + c_e + \mu s_1)}{4\alpha(1-\alpha)}$$

According to the retailer's optimal profit, it can be obtained: When there are dual channels, the retailer's optimal profit π is an increasing function of the acceptance level α of the network channel, and a decreasing function of the distribution cost sensitivity μ.

Proof:

$$\frac{\partial\pi}{\partial\alpha}=\frac{\left[\alpha^2+(1-2\alpha)(s_2+c_e+\mu s_1)\right](\alpha c_r-s_2-c_e-\mu s_1)}{4\alpha^2(1-\alpha)^2}+\frac{(\alpha-s_2-c_e-\mu s_1)}{4\alpha^2(1-\alpha)^2}-\frac{\alpha^2(1-c_r)(c_r-s_2-c_e-\mu s_1)}{4\alpha^2(1-\alpha)^2}$$

$$=\frac{\left[\alpha^2+(1-2\alpha)(c_e+\mu s_1)+\alpha c_r(1-\alpha)-\alpha^2(1-c_r)\right](\alpha c_r-s_2-c_e-\mu s_1)}{4\alpha^2(1-\alpha)^2}$$

$$=\frac{\left[(1-\alpha)(s_2+c_e+\mu s_1)+\alpha(c_r-s_2-c_e-\mu s_1)\right](\alpha c_r-s_2-c_e-\mu s_1)}{4\alpha^2(1-\alpha)^2}>0$$

$$\frac{\partial\pi}{\partial\mu}=\frac{-s_1(\alpha c_r-s_2-c_e-\mu s_1)}{2\alpha(1-\alpha)}<0$$

Corollary 3. After the online channel is opened, the total market demand of the dual channel is greater than or equal to the total market demand of the single channel, and the market demand of the offline channel of the dual channel is less than or equal to the offline market demand of the single channel.

Proof: When only retail channels exist,

$$D_s=1-p_r=1-\frac{1+c_r}{2}$$

When there are dual channels,

$$D_d=D_r+D_e=1-\frac{p_e+\mu s_1}{\alpha}=1-\frac{\alpha+s_2+c_e+\mu s_1}{2\alpha}$$

$$D_d-D_s=(1-\frac{\alpha+s_2+c_e+\mu s_1}{2\alpha})-(1-\frac{1+c_r}{2})$$

$$=\frac{\alpha c_r-s_2-c_e-\mu s_1}{2\alpha}\geq 0$$

$$D_s-D_r^d=(1-\frac{1+c_r}{2})-(1-\frac{1+c_r-\alpha-s_2-c_e-\mu s_1}{2(1-\alpha)})$$

$$=\frac{\alpha c_r-s_2-c_e-\mu s_1}{2(1-\alpha)}\geq 0$$

4 Numerical Analysis

Let $c_r=0.9, c_e=0.3, s=0.1$. In order for the analysis to be meaningful, it is necessary to meet the two conditions of dual-channel existence, $\alpha c_r-s_2-c_e-\mu s_1\geq 0$, and retail channel demand greater than or equal to zero,

$1-\alpha-c_r+s_2+c_e+\mu s_1\geq 0$.

Table 2. Optimal pricing and profit of dual channels under given parameters

c_r	c_r	s	*a*	μ	s_1	p_e^*	p_r^*	π_e^*	π_r^*	π^*
0.6	0.3	0.1	0.8	1.2	0.02	0.578	0.800	0.047	0.002	0.049

4.1 Analysis of the influence of consumers' online channel preference on dual channels

When $\mu=1.2$ $s_1=0.02$, $\alpha\in[0.67,0.8]$.

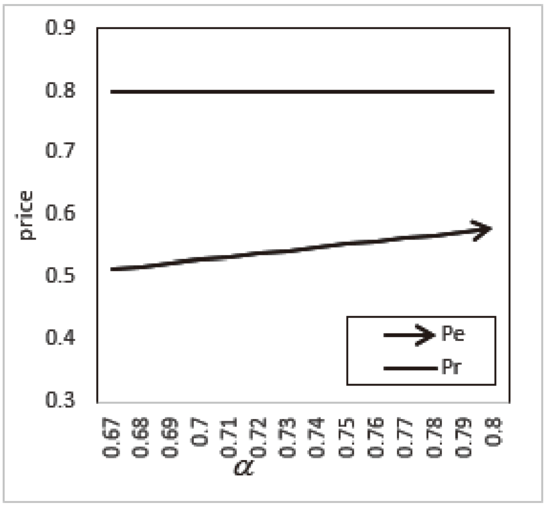

Figure 4 Optimal pricing of dual channels under α changes

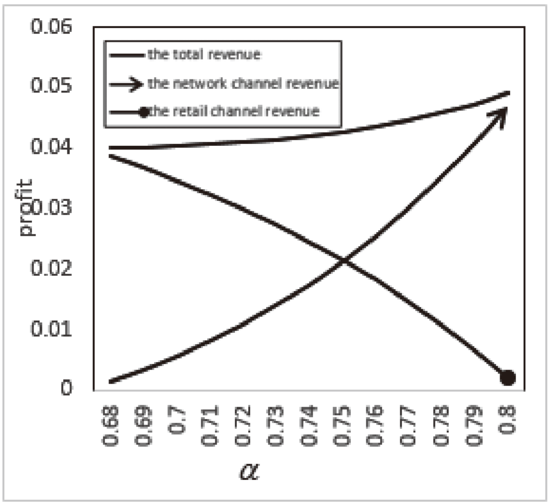

Figure 5 Optimal profit of dual-channel retailers under α changes

4.1.1 The influence of consumers' online channel preference on dual channel pricing

It can be seen from Figure 4 that the pricing of retail channel products has nothing to do with the acceptance of online channels, because the price of retail channel products mainly depends on the cost of the retail channel. The pricing of online channel products is always lower than that of retail channels, which is caused by the fact that the cost of retail channels is higher than that of online channels. The pricing of online channels is positively correlated with the acceptance of online channels. This shows that the greater consumers' preference for online channels, the more they will accept higher online channel sales prices. It further shows that with the strengthening of consumers' willingness to shop online, the promotion of large-scale fresh food chain stores to join online channels as a supplement to traditional channels.

4.1.2 The Influence of Online Channel Preference on Retailers' Profits

It can be seen from Figure 5 that consumer preference for online channels is negatively correlated with retail channel profits, positively correlated with online channel profits, and positively correlated with retailers' total profits. This is because as the preference for online channels increases, the demand for online channels increases faster than the demand for retail channels decreases, so retailers' profits increase. This shows that as customers' acceptance of online channels increases, retailers can appropriately increase the pricing of online channel products to obtain higher profits. At the same time, for retailers, when consumers' acceptance of online channels increases, they need to strengthen the advantages of retail channels in terms of service and consumer experience, increase consumer satisfaction, and attract loyal consumer groups to ensure their own profit.

4.2 Analysis of the impact of consumers' sensitivity to bearing distribution costs μ on dual channels

When $\alpha = 0.8$ $s_1 = 0.02$, $\mu \in [1,5]$,

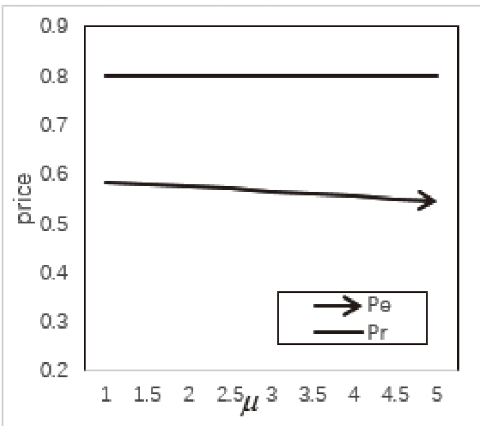

Figure 6 Optimal pricing of dual channels under μ changes

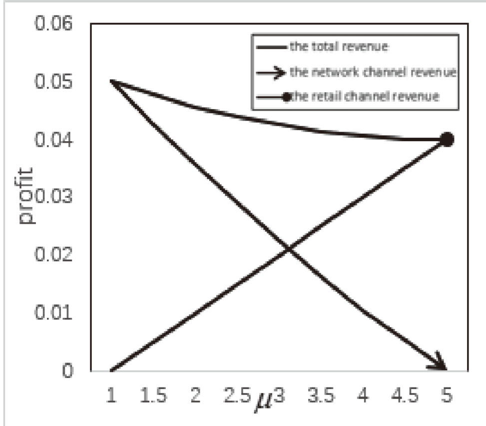

Figure 7 Optimal profit of dual-channel retailers under μ changes

4.2.1 The impact of the sensitivity of distribution costs on dual-channel pricing

It can be seen from Figure 6 that the pricing of online channels is negatively correlated with the acceptance of online channels. This shows that the more sensitive consumers are to distribution costs, the more they will accept lower online channel sales prices.

4.2.2 The impact of the sensitivity of distribution costs on retailers' profits

It can be seen from Figure 7 that the sensitivity of consumer distribution costs is positively correlated with retail channel profits, negatively correlated with online channel profits, and negatively correlated with retailers' total profits. This shows that retailers can appropriately reduce the distribution costs of online channels. At the same time, they need to improve the advantages of online channels in terms of delivery service quality and online shopping convenience to maintain and expand the demand for online channels and ensure their own profits.

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